PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

11/2003

RECOVERY & SEQUESTRATION OF CO_2 FROM STATIONARY COMBUSTION SYSTEMS BY PHOTOSYNTHESIS OF MICROALGAE

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Background

Most anthropogenic carbon dioxide (CO_2) emissions result from the combustion of fossil fuels for energy production. Photosynthesis has long been recognized as a means, at least in theory, to sequester anthropogenic CO_2. Aquatic microalgae have been identified as fast growing species whose carbon fixing rates are higher than those of land-based plants by one order of magnitude. A large-scale photobioreactor would be similar to a large display of solar panels, except instead of producing electricity, the solar energy would serve though photosynthesis by microalgae to convert CO_2 from fossil fuel combustion to stable carbon compounds for sequestration. Some high-value products would also be produced to offset the carbon sequestration cost.

An ideal methodology for photosynthetic sequestration of anthropogenic carbon dioxide has the following characteristics: (1) a high rate of CO_2 uptake, mineralization of CO_2, (2) resulting in permanently sequestered carbon, (3) produce revenue from sale of high value products, and (4) use of concentrated, anthropogenic CO_2 before it enters the atmosphere. In this research program, Physical Sciences Inc. (PSI), Aquasearch, and the Hawaii Natural Energy Institute at the University of Hawaii are jointly developing technology for the recovery and sequestration of CO_2 from stationary combustion systems by photosynthesis of microalgae. The research is aimed primarily at quantifying the efficacy of microalgae-based carbon sequestration at an industrial scale. The principal research activities will be focused on demonstrating the ability of selected species of microalgae to effectively fix carbon from typical power plant exhaust gases. The results will be used to evaluate the technical efficacy and associated economic performance of large-scale photobioreactor carbon sequestration facilities.

Primary Project Goal

The primary project goal is to develop technologies pertaining to: (1) treatment of effluent gases from fossil fuel combustion systems; (2) transferring CO_2 into aquatic media; and (3) converting CO_2 efficiently by photosynthetic reactions to materials to be reused or sequestered.

Recovery & Sequestration of CO_2 from Stationary Combustion Systems by Photosynthesis of Microalgae

PROJECT PARTNERS

Physical Sciences, Inc.

University of Hawaii

Aquasearch

COST

Total Project Value:	$2,361,111
DOE:	$1,682,028
Non-DOE Share:	$ 679,083

Objectives

- Determined the effect of process variables on the production of various strains of microalgae
- Optimize and demonstrate an industrial-scale photobioreactor
- Perform economic analyses of commercial-scale microalgal CO_2 sequestration technology

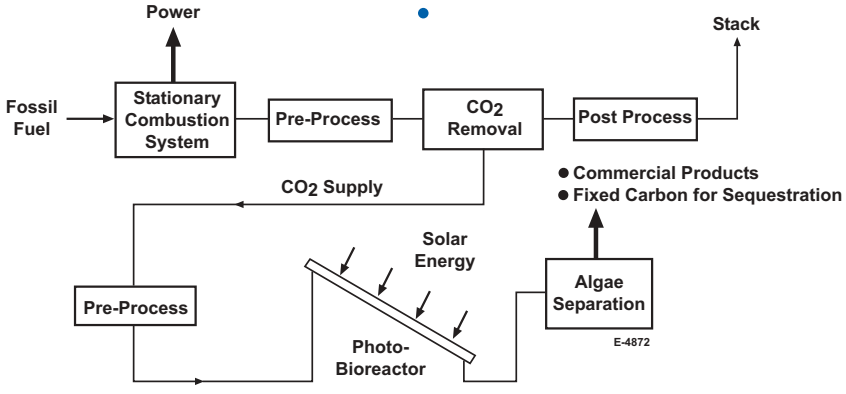
Accomplishments

Tested 50 strains of microalgae for growth at different temperatures; analyzed 34 strains for high-value pigments; tested 21 strains for tolerances to simulated flue gases; and tested 28 strains for potential carbon sequestration into carbonates for long-term storage. Tested CO_2 removal process, CO_2 injection device, process control devices, and algae separation process for scaled-up photobioreactor.

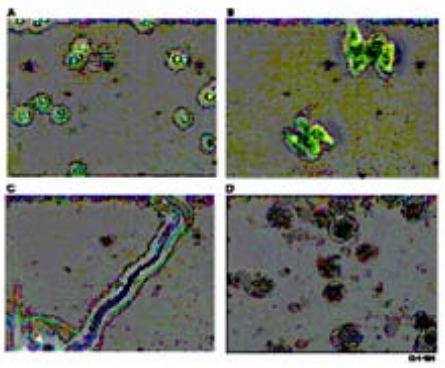
PSI delivered its coal reactor to Aquasearch. Aquasearch and PSI prepared work on direct feeding of coal combustion gas to microalgae. Aquasearch started their effort on economic analyses of commercial scale photobioreactor. University of Hawaii continued effort on system optimization of the CO_2 sequestration system.

Benefits

This project represents a radical departure from the large body of science and engineering in the area of gas separation. This research has significant potential to create scientific and engineering breakthroughs for the operation of controlled, high-throughput, photosynthetic carbon sequestration systems. This type of system will reduce carbon dioxide emissions generated by fossil fueled power plants. The microalgae used and grown in this process can produce high-value pharmaceuticals, fine chemicals, and commodities. Revenues from the sale of these products can help offset carbon sequestration costs.



Recovery and sequestration of CO_2 from stationary combustion systems by photosynthesis of microalgae



Microphotographs of four types of algal cells at a magnification of 400x showing differences in size and morphology